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ORIGINAL ARTICLE

The role of fibular fixation in the treatment of tibia diaphysis distal third fractures

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KEYWORDS

Tibial fractures;
Fibula;
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Summary

Introduction: Combined fractures of the distal third of tibia diaphysis and fibula diaphysis are a common orthopedic injury. There is an ongoing debate about the necessity of fibular fixation when associated to distal third tibial fracture. This study aims at evaluating the role of fibular fixation in the treatment of distal third tibial fractures.

Hypothesis: We hypothesized that fixation of the fibula increases the stability of fixation in distal third tibial and fibular fractures.

Materials and methods: In a randomized clinical trial, 53 patients with concomitant fractures of tibia and ipsilateral fibula at distal third level were recruited in this study during a 23-month period. Patients were randomized in two groups: patients with fibular fixation (case group) and without fibular fixation (control group). The patients were followed up for at least 6 months postoperatively.

Results: There were seven cases exhibiting malalignment on immediate postoperative radiographs. Six of them were in group II (control group) and one was in group I (case group) ($P=0.084$). We didn't find nonunion in group I and we found three patients in group II ($P=0.141$). Infection was one in group I and two in group II on Gustillo II injuries ($P=0.516$).

Conclusion: Despite its low count of patients, our study didn't show any advantage to fix the fibula fracture associated to distal third of tibia diaphysis fracture. It didn't show either an increase of complication after fibula open reduction and internal fixation.

Level of evidence: Level III. Randomized prospective study.

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Introduction

In the U.S, tibial fracture is the most common fracture and trauma is the common cause of tibio-fibular fracture [1]. External fixation, plate and intramedullary nailing (IMN) are the surgical options for tibial fractures [2]. Delayed union and nonunion could be complications of tibial fractures [3]. Distal tibial fractures occur in 37.8% out of all tibial fractures. Tibial fractures are combined with fibular fracture in 77.7% of the cases [4]. Treatments of distal tibial fractures are usually different from diaphyseal fractures and are frequently associated with worse results and complications [5]. There seems to be a controversy about fibular fixation in the treatment of distal tibial fractures. Several studies about the effects of fibular fixation on distal tibial fractures have been done [6–8]. Theoretical benefits of fibular fixation are the possibility of a better control over the length and rotation of the limb and better anatomical alignment [9]. On the other hand, fibular fixation may result in delayed union or nonunion because it inhibits the cyclic loading on the tibial fracture site [10].

We performed a randomized clinical trial study to determine the role of fibular fixation in distal third tibial diaphysis and fibular fractures. We hypothesized that fixation of the fibula increases the stability of fixation in distal third tibial and fibular fractures.

Material and methods

Between April 2007 and September 2009, 150 patients with combined tibial and fibular fracture were admitted to our hospital.

Patients who were eligible for the study were those who had combined tibial and fibular fractures in the distal third of tibia diaphysis. The fracture should be extra-articular.

Patients with injuries which occurred within the 14 days of admission were included in the study.

Exclusion criteria were refractures, pathologic fractures, articular involvement, isolated tibial fractures, any evidence of syndesmotic injury, Gustilo and Anderson type III B and III C open fractures, vascular and soft tissue injuries, multiple fractures and tibial fractures in the middle and proximal third.

A separate blocked randomization procedure, based on random number generated by SPSS statistical package was used to assign the patients to group I with fibula fixation or to group II without fibula fixation. Randomization was performed after it had been determined that the inclusion criteria had been met.

Ethics committee/institutional research board approval was obtained prior to the initiation of the trial (in Tabriz University of Medical Sciences Ethics committee with a number of 8964). All patients enrolled in the study signed an informed consent form and were willing to return to the required postoperative follow-up visits.

Operative technique

Reamed intramedullary nail was placed in all of the patients. The surgery was performed between first day and 13th days

from the time of injury by two surgeons. All procedures were performed under spinal or general anesthesia. All patients had locking nail placed and were statically locked. The distal locking bolt configuration was two medial to lateral bolts in all patients. In two patients (one in each group), a third bolt was added in order to increase the stability. In the second group prior to fixation of the tibia, the fibula was fixed by a 3.5 mm DCP or one-third tubular plate through lateral approach. Based on preoperative radiographs, no investigation was performed during the surgery to rule out the syndesmotic injury. Open fractures in both groups were treated with debridement and irrigation with delayed primary closure.

We allowed range of motion of the ankle and knee immediately postoperatively. In the first 3 months, we also allowed partial weight-bearing at which time weight-bearing was progressed depending on radiographic signs of union. Follow-up radiographs were taken 2, 6 and 12 weeks after surgery and then every 6 weeks until clinical and radiographic signs of union were evident. Results including malunion, nonunion and infections analyzed and expressed as mean \pm standard deviation and also frequency and percentage. The data were analyzed by SPSSTM 15 software. Quantitative variables were compared by using Student T-test (independent samples) and Mann-Whitney U-test. Comparison of the qualitative variables (categorical) has been done by using Chi-Square Test or Fisher's Exact Test depending on the conditions. In all investigated cases, the results have been known statistically significant in case of $P \leq 0.05$. To limit the possibility of a bias, all measurements were done by an independent examiner. We used the method of Freedman and Johnson to determine the loss of reduction [11]. Malunion was defined as a varus – valgus angulation of more than 5° and an anterior-posterior angulation of more than 10° [12].

Malrotation was assessed clinically. We compared the proportion of cases losing reduction that were in group I to those in group II. Nonunion was defined as absence of radiological progression of union and existence of pain at the fracture site until 6 months.

Results

We enrolled 53 patients eligible to this study. In the case group were 24 patients with the mean age of 24.2 ± 7.8 (male = 22 and female = 2). In the control group were 29 patients with the mean age of 28.6 ± 10.3 (male = 23 and female = 6). Patients were followed about 6 months.

The most common mechanism of injury in both groups was motorcycle accident (58.3% in the case group and 41.4% in the control group). Open fracture were 11 out of 24 patients (45.8%) in group I and 17 out of 29 patients (58.6%) in group II ($P = 0.257$) (Table 1).

The study duration was 23 months. The average follow-up period was 6 months (range 4 to 8 months).

Malalignment on immediate postoperative radiographs were stored on seven cases. Among them, six were in group II (three pure varus – valgus angulation and three combined varus – valgus and anterior-posterior angulation) and one was in group I (pure varus – valgus angulation) ($P = 0.084$) (Figs. 1, 2). Three patients with an immediate malreduction

Table 1 Comparison of some demographic data, the injury mechanism and Gustilo & Anderson open fracture classification of tibia and fibula fractures.

	Group I	Group II	P value
Sex			0.195
Female	2	6	
Male	22	23	
Age (years)	24.2 ± 7.8 (16–41)	28.6 ± 10.3 (17–61)	0.090
Mechanism of injury			
Falling	6 (25)	10 (34.5)	
Car accident	2 (8.3)	3 (10.3)	
Car-pedestrian accident	2 (8.3)	2 (6.9)	
Motorcycle accident	14 (58.3)	12 (41.4)	
Other	0	2 (6.9)	
Gustilo & Anderson open fracture classification			
Type I	0	0	
Type II	0	0	
Type IIIA	11 (45.8)	17 (58.6)	0.257

Data are presented as Means ± SD, frequency (percentage).

underwent corrective surgery within 2 weeks after the first operation with satisfying results and they maintained their reduction until the end of follow-up. Four patients, one in group I and three in group II did not accept second surgery and were excluded from the follow-up.

During the follow-up period, loss of reduction occurred in none of 23 patients in group I and in four patients (four of 26 patients) (15.3%) in group II (three pure varus – valgus malunion and one combined varus – valgus and anterior-posterior malunion) ($P=0.071$). All four patients had varus – valgus angulation.

One patient (4.3%) in group I and two patients (7.6%) in group II who had Gustilo and Anderson type IIIA open fracture developed superficial infection ($P=0.516$) that required

irrigation and debridement as well as IV antibiotic therapy with success.

One patient in group I and five patients in group II had an insufficient callus after 6 months ($P=0.125$), but they progressed to union with observation until 3 months. Nonunion occurred in none of 23 patients in group I and three of 26 patients of group II (11.5%) ($P=0.141$). Two of them were open fracture. All of them had oligotrophic nonunion, one of them was treated by nail replacement 6 months after first operation, the other two patients were treated by nail dynamization 8 months after the first operation. All of them achieved bone healing after second surgery (Table 2).

Discussion

We tried to investigate the role of fibular fixation in distal third tibial fracture in this study. Both groups were not different regarding the demographic characteristics and tibial



Figure 1 Malalignment immediately after operation in fibular fixation group.



Figure 2 Malalignment immediately after operation in group II.

Table 2 Comparison of some clinical results, loss of reduction and complications in two group.

	Group I	Group II	P value
Initial inadequate tibial reduction	1 (4.16)	6 (20.68)	0.084
Loss of reduction	0	4 (15.3)	0.071
Infection	1 (4.2)	2 (6.9)	0.516
Nonunion	0	3 (11.5)	0.141

Data are presented as frequency (percentage).

fixation by IMN. We didn't found any differences between the both group regarding all criteria but this study had several limitations. The volume of each group was small but statically worth enough regarding the main criteria: with or without malalignment. However, a larger number of cases would have given more power to this study. Another bias could be the number of different surgeons. Finally, the malalignment in rotation was only assessed clinically without precise assessment by CT scan.

Several different groups of studies researched the role of fibular fixation in the treatment of tibial fracture. Some studies emphasized that fibular fixation leads to an increasing risk of complications. Marsh et al. reported an increasing risk of infection when using the fibular fixation method combining tibial and fibular fracture [10]. In our study, there was no significant difference in the prevalence of infection as an adverse effect of fibular fixation. Williams et al. reported an increase of nonunion and infection rate when fibular fixation was applied in the tibial fracture treatment [13]. It is believed that soft tissue injuries occurring during high-energy combined tibial and fibular fractures would increase the risk of infection and skin necrosis. Therefore, it is necessary to manipulate these injuries as least as possible including fibular fixation [14]. In our study, regarding postoperative infection, there is no significant difference between the both groups. However, most of these studies [10,13,14] have been done in tibial plafond fractures and it is not truly comparable with distal non-articular tibial fractures.

Teitz et al. studied the effects of fibular sparing on distal tibial fracture [15]. They reported that sparing the fibula may result in rapid union of the fracture because of the inhibiting cyclic compression theory (factor that is necessary to physiologic repairing of fracture). Some studies recommended fibulectomy or fibular osteotomy in tibial nonunion.

There is another theory that believes fibular fixation does not affect tibial fracture treatment [16]. Varsalona and Liu reported that in extra-articular fractures of combined tibia and fibula, fixation of the fibula has no benefit and is not recommended [14]. Nork et al. and Obrensky and Medina express no effect of fibular fixation on treatment outcome of patients with tibial fractures, also they reported that IMN is an effective alternative with less malalignment and complications for the treatment of distal metaphyseal tibial fractures [17,18], that was correlated with our study. Third group of studies comment some beneficial effects of fibular fixation in same level combined tibial and fibular fractures and have suggested concurrent fibular fixation. Morrison et al. published a clinical trial study's results that reported fibular fixation would preserve reduction of tibia [19]. Kumar et al. reported that fibular plate fixation increased the initial rotational stability after distal tibial fracture in comparison

with patients that had tibial IMN alone [20]. Others reported that the treatment of distal tibial shaft fractures by using unreamed nailing without any contact by additional fragment or without stabilizing the fibula should be carefully reconsidered. Also has been mentioned that the highest rate of complications were seen in fibula distal fractures without fibular additional plating and recommended fibular fixation in combined tibial and fibular fracture [21–23]. Morin et al. in a cadaveric study, show off a significant difference in axial rotation stability when fixing the fibula [7]. However, this difference may not be clinically important for them. Egol et al. studied on 72 patients and reported malalignment was lower in the fibular fixation group compared to tibial fixation alone [5]. Regarding tibio-fibular stability, no investigation had been performed in our study, during surgery about a syndesmotic injury. Nevertheless, we didn't notice at the last follow-up, patients with obvious radiography showing distal tibio-fibular gap.

We didn't use the fracture table in our cases and that could affect the alignment. CECOP study recommends to use the fracture table to prevent malreduction [24]. However, comparing the reoperation rate in the both groups, fibular fixation is advisable when fracture table is not used. Bonneville et al. reported that the tibial axes were statistically better corrected when the fibula was treated with fixation [25]. But in four of the 11 cases of axial tibial malunion, the primary fibular fixation caused or worsened them. In our study, fixation of fibula had no effect in the nonunion and malunion of tibial fracture.

Conclusion

Despite the short effective, our study didn't show any advantage to fix the fibula fracture associated to distal third of tibia diaphysis fracture. It didn't show either an increase of complication after fibula open reduction and internal fixation.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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C: statistical analysis; D: data interpretation; E: manuscript preparation; F: literature search; G: funds collection.

References

- [1] Canale S. Campbell's operative orthopaedics. 10 ed. Philadelphia: Mosby; 2003.
- [2] Germann CA, Perron AD, Sweeney TW, Miller MD, Brady WJ. Orthopedic pitfalls in the ED: tibial plafond fractures. *Am J Emerg Med* 2005;23:357–62.
- [3] McKoy BE, Stanitski CL. Acute tibial tubercle avulsion fractures. *Orthop Clin North Am* 2003;34:397–403.
- [4] Bucholz R, Heckman J, Court-Brown C. Rockwood and Green's fractures in adults. 6 ed. Philadelphia: Lippincott Williams & Wilkins; 2006.
- [5] Egol KA, Weisz R, Hiebert R, Tejwani NC, Koval KJ, Sanders RW. Does fibular plating improve alignment after intramedullary nailing of distal metaphyseal tibia fractures? *J Orthop Trauma* 2006;20:94–103.
- [6] Borg T, Larsson S, Lindsjö U. Percutaneous plating of distal tibial fractures. Preliminary results in 21 patients. *Injury* 2004;35:608–14.
- [7] Morin PM, Reindl R, Harvey EJ, Beckman L, Steffen T. Fibular fixation as an adjuvant to tibial intramedullary nailing in the treatment of combined distal third tibia and fibula fractures: a biomechanical investigation. *Can J Surg* 2008;51:45–50.
- [8] Vallier HA, Cureton BA, Patterson BM. Randomized, prospective comparison of plate versus intramedullary nail fixation for distal tibia shaft fractures. *J Orthop Trauma* 2011;25:736–41.
- [9] Khalily C, Behnke S, Seligson D. Treatment of closed tibia shaft fractures: a survey from the 1997 Orthopaedic Trauma Association and Osteosynthesis International-Gerhard Kuntscher Kreis meeting. *J Orthop Trauma* 2000;14:577–81.
- [10] Marsh JL, Bonar S, Nepola JV, DeCoster TA, Hurwitz SR. Use of an articulated external fixator for fractures of the tibial plafond. *J Bone Joint Surg Am* 1995;77:1498–509.
- [11] Freedman EL, Johnson EE. Radiographic analysis of tibial fracture malalignment following intramedullary nailing. *Clin Orthop Relat Res* 1995;25–33.
- [12] Vallier HA, Le TT, Bedi A. Radiographic and clinical comparisons of distal tibia shaft fractures (4 to 11 cm proximal to the plafond): plating versus intramedullary nailing. *J Orthop Trauma* 2008;22:307–11.
- [13] Williams TM, Marsh JL, Nepola JV, DeCoster TA, Hurwitz SR, Bonar SB. External fixation of tibial plafond fractures: is routine plating of the fibula necessary? *J Orthop Trauma* 1998;12:16–20.
- [14] Varsalona R, Liu GT. Distal tibial metaphyseal fractures: the role of fibular fixation. *Strateg Trauma Limb Reconstr* 2006;1:42–50.
- [15] Teitz CC, Carter DR, Frankel VH. Problems associated with tibial fractures with intact fibulae. *J Bone Joint Surg Am* 1980;62:770–6.
- [16] DeLee JC, Heckman JD, Lewis AG. Partial fibulectomy for ununited fractures of the tibia. *J Bone Joint Surg Am* 1981;63:1390–5.
- [17] Nork SE, Schwartz AK, Agel J, Holt SK, Schrick JL, Wniquist RA. Intramedullary nailing of distal metaphyseal tibial fractures. *J Bone Joint Surg Am* 2005;87:1213–21.
- [18] Obremskey WT, Medina M. Comparison of intramedullary nailing of distal third tibial shaft fractures: before and after traumatologists. *Orthopedics* 2004;27:1180–4.
- [19] Morrison KM, Ebraheim NA, Southworth SR, Sabin JJ, Jackson WT. Plating of the fibula. Its potential value as an adjunct to external fixation of the tibia. *Clin Orthop Relat Res* 1991;209–13.
- [20] Kumar A, Charlebois SJ, Cain EL, Smith RA, Daniels AU, Crates JM. Effect of fibular plate fixation on rotational stability of simulated distal tibial fractures treated with intramedullary nailing. *J Bone Joint Surg Am* 2003;85-A:604–8.
- [21] Duda GN, Mandruzzato F, Heller M, Goldhahn J, Moser R, Hehli M, et al. Mechanical boundary conditions of fracture healing: borderline indications in the treatment of unreamed tibial nailing. *J Biomech* 2001;34:639–50.
- [22] Richter D, Hahn MP, Laun RA, Ekkernkamp A, Muhr G, Ostermann PA. Ankle para-articular tibial fracture. Is osteosynthesis with the unreamed intramedullary nail adequate? *Chirurg* 1998;69:563–70.
- [23] Strecker W, Suger G, Kinzl L. Local complications of intramedullary nailing. *Orthopade* 1996;25:274–91.
- [24] Terver S, Miazolo N, Hery JY. Prospective and retrospective study of complications after centromedullary nailing of weight-bearing bones (CECOP study). *Rev Chir Orthop Reparatrice Appar Mot* 2005;91:155–82.
- [25] Bonneville P, Lafosse JM, Pidhorz L, Poichotte A, Asencio G, Dujardin F. Distal leg fractures: how critical is the fibular fracture and its fixation? *Orthop Traumatol Surg Res* 2010;96:667–73.